RESOURCE ROAD PLANNING

Guidelines

Alberta

RESOURCE ROAD PLANNING GUIDELINES for the Green Area of Alberta

Prepared by
G. L. Fisher
Forest Land Use Branch

1982
EDMONTON

Alberta
ENERGY AND
NATURAL RESOURCES
Forest Service

ENR Technical Report Number: T/25
ISBN 0-86499-046-4

FOR ADDITIONAL COPIES OF THE REPORT, CONTACT:

Alberta Energy and Natural Resources
Resource Information Services
South Petroleum Plaza
Edmonton, Alberta, Canada
T5K 2C9
Phone: 403-427-7003

ABSTRACT

The road planning guidelines describe five classes of roads for use by the timber and petroleum industries. Recreation roads and other types of roads that may be required by the Alberta Forest Service are also included. Environmental protection guidelines are provided for the planning, design, construction, and abandonment of each class of road. The avoidance of environmental impacts in the planning phase and selection of an alignment that will serve the needs of multiple users are key elements of these guidelines.

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FOREWORD

These guidelines are provided to assist the various users on all aspects of road development with considerations on the planning and environmental parameters in the Green Area of Alberta.

Planning is the key to minimizing resource impacts. This requires more front-end planning on the part of the developer. Applications are often delayed during the agency review process due to inconsistencies, inadequate information or conflicts that front-end planning may have resolved. Amendments to the application are often the result with a further delay in application processing. Use of these guidelines should avoid unnecessary amendments to an application and should benefit the applicant in terms of application approval turn around time.

These guidelines may be updated periodically as better information becomes available.

ACKNOWLEDGEMENTS

Appreciation is extended to members of the Road Planning Task Force: G. Armitage (Alberta Forest Service, Whitecourt), H. Pratley (Timber Management Branch, Edmonton), and C. Quintillio (Alberta Forest Service, Grande Prairie). Thanks are given to the Forest Superintendents, Alberta Forest Service Branch Directors and the Fish and Wildlife Division, all of Energy and Natural Resources, for their review and critique during the draft stages. Special thanks go to the many Forest Service Personnel who assisted with the initial ground work and to G. H. Passey for his guidance and valuable expertise.

1. INTRODUCTION

1.1 PURPOSE

The purpose of this report is to initiate road planning guidelines that will assist resource road developers with design enhancement and advanced planning of roads in the Green Area (Figure 1). Access has been traditionally constructed by industry and government with a single purpose in mind. Initial access for development establishes the pattern of road development but may not meet future needs of resource users. Each resource developer has road requirements unique to his field. As a result, there is a need to coordinate and integrate the development of access to resources so that they complement each other and avoid duplication. However, it is difficult to avoid road duplication when initial access is constructed without adequate planning or consideration for other users.

1.2 OBJECTIVE

The objectives of the road planning guidelines are:

1. To coordinate and integrate the operational planning of roads to various types of resource developments in the Green Area.
2. To determine, during the planning phase, the environmental impact of a proposed road and determine mitigative requirements.
3. To provide guidelines for developers on engineering and environmental parameters.
4. To provide guidance to industry and Alberta Energy and Natural Resources (ENR) field and planning staff who are involved in developing roads and road networks.

1.3 BACKGROUND

Planning, environmental and engineering guidelines for road development are necessary for the orderly development and protection of natural resources. Road development is one of the most environmentally damaging activities in forested areas and often leads to serious and unnecessary degradation of natural resources.

At present, there are no uniform environmental and engineering design standards for single and/or multiple purpose roads.

Existing access roads within the Green Area have various classifications and design standards. Before 1975, an old Alberta Forest Service (AFS) road classification and design system described three road classes designed primarily as access for forest management, recreation and for other special areas. Since 1975, all AFS-required access needs (excluding industrial) have been designed and constructed by Alberta Transportation (AT).

There are currently six Forest Management Agreements (FMAs) in Alberta. Each FMA has its own road classification and design standards as described within respective operating ground rules. In 1977, an AFS policy was developed regarding special operating conditions of timber licences and commercial timber permits. Included in this policy were road classification and design standards. An ENR report (**Timber Harvest Cut Block Design**) published in 1977 describes timber harvest and cut block design guidelines as well as road classification and design standards. Comparing each FMA, there are similarities and differences between the various road classification and design standards.

The petroleum industry in Alberta does not have a uniform classification for road construction. For many petroleum companies, roads are designed to fit the individual company's needs as its requirements vary through the different phases of exploration and development.

Road classification and design standards for mineral exploration and development are again varied due to their location and differing requirements. Coal companies follow the general specifications in the Coal Mines Safety Act and Regulations; however, road design specifications must meet approval of the Energy Resources Conservation Board (ERCB). Mineral development usually requires a high standard road with many built in safety features.

Roads developed for recreation access in the Green Area are designed and constructed by AT as main access to the recreation area boundary. Design specifications vary within and between Forest Districts depending on the location of the road and prospective use by recreationists.

1.4 LEGISLATION

The Forests Act, Forest and Prairie Protection Regulations Part II, The Public Lands Act and The Land Surface Conservation and Reclamation Act provide some regulations governing industrial roads. However, these provide only a general legal structure for road development.

The present legislation is deficient in the phases of road development from initial planning, design, construction, revegetation and maintenance through to reclamation. This report addresses these deficiencies.

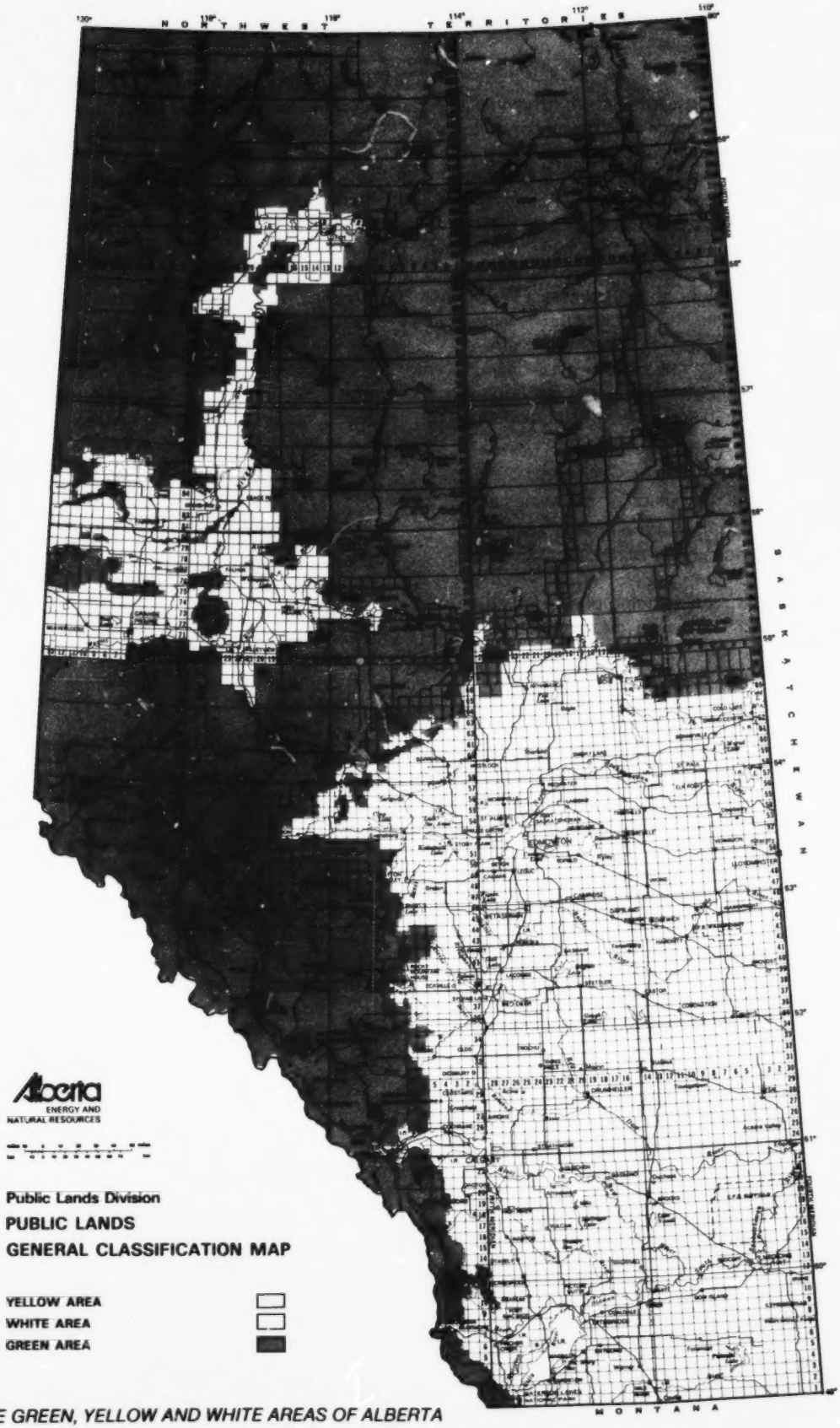

Figure 1. THE GREEN, YELLOW AND WHITE AREAS OF ALBERTA

PART I :

Integrated Road Classification and the Route Selection Process

2. INTEGRATED ROAD CLASSIFICATION

2.1 ROAD CLASS DESCRIPTIONS

The integrated road classification is composed of five classes of roads for use by the petroleum industry, timber industry, government, and for recreational access in the Green Area. These roads are either permanent (2 years or more) or temporary (less than two years). Table 1 describes each class of road for each of these resource users. The table also illustrates how a class of road in one category relates to the same class of road in the other categories. This relationship can assist the planner in the design of a road to suitably accommodate other potential uses and users if the need is indicated. Although this classification pertains to these resource users in the Green Area, it can be adapted to accommodate other uses such as coal exploration and development.

This classification will apply to the planning, design and construction of any new roads and any upgrading of existing roads and road systems.

2.2 MULTIPLE-USE CONSIDERATIONS

Roads that have originally been built for one purpose are very often later used and upgraded for another purpose. Road rights-of-way often become a focus for other linear facilities. It is important that, in selecting a road class and in locating a road (especially key development roads), other uses and users be considered.

Road rights-of-way are often utilized to locate other facilities such as powerlines, pipelines and telemetry cables (Photo 1). These rights-of-way usually require additional clearing to accommodate these facilities (Photo 2) and, more often, new rights-of-way are used. The linear aspect of these facilities is important in the design and location of the road. A road with many curves would not be as suitable for locating a pipeline as a road with long tangents and few curves. A road to an exploratory drilling site often becomes the focal location for advanced road development required by development drilling. The initial right-of-way (location and design) becomes very significant if the total infrastructure that may later develop is considered.

Road Use Agreements are agreements signed between the holder of the Licence of Occupation (LOC) for the road and another industrial user. This occurs most often between the timber industry and petroleum industry or among petroleum users. Problems with other road developments are often associated with these agreements, especially between the timber industry and petroleum industry. Load and hauling requirements are often different for these users. For example a road built by the petroleum industry is often not of the standards required by the timber industry. This particularly pertains to the grade and subgrade portion of the road. If a petroleum user constructs a road in an area the timber industry is responsible for (i.e., an FMA area), the future use or potential use of that road by the timber industry (in accordance to their annual and long-term operating plans) should be considered. The minimum joint effort should at least have an alignment selected that will satisfy both users now and in the future.

Except at controlled gates or at controlled access points, the general public has access to all roads. The major industrial roads receive more use by the public than other industrial roads, primarily for recreation. The potential for a recreational use should be considered during the planning stages. Key considerations are road location, design, aesthetics and safety.

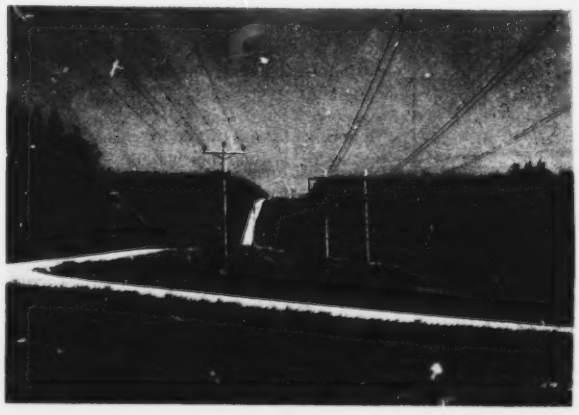

Photo 1. A multiple-use right-of-way illustrating an access road, 25 KV and 138 KV powerlines and a pipeline on the right side. Notice that the powerlines and pipeline are located on one side of the road.

Photo 2. Additional right-of-way was cleared to allow for placement of a pipeline. This right-of-way would be difficult to upgrade as the powerline and pipeline are located on either side of the road.

Table 1

INTEGRATED CLASSIFICATION OF ROADS

ROAD CLASS	*TIMBER*	*PETROLEUM*	*FOREST*
I	Permanent, year-round access to a working area. 20 years +.		
II	Permanent, year-round access. A branch road serving as a collector or as main winter haul road. 10 years +.	Permanent, year-round access to petroleum fields and/or processing facilities. 10 years +.	Permanent, year-round access to recreation areas. 10 years +.
III	Permanent; access available during dry or frozen periods to cut blocks. 2 to 20 years.	Permanent, year-round access. A collecting system for petroleum facilities. 10 years +.	Permanent, year-round or seasonal access to recreation areas. 10 years +.
IV	Temporary; access during dry or frozen periods between and within cut blocks. 2-5 years or term of operations.	Permanent, year-round access to petroleum facilities such as wellheads. 10 years +.	Permanent, year-round or seasonal access for fire control towers, AFS gravel pits and recreation. 10 years +.
V	Temporary access during frozen periods between and within cut blocks. 2 years or less.	Temporary access during dry or frozen periods for exploration drilling. 2 years or less.	Temporary, seasonal access for reforestation and reclamation programs and other resource uses. 2 years of less.

NOTE: Descriptions are based on the needs of resource users in the Green Area of Alberta. All classes may or may not be used depending on geographical location or by the need for the use of only some classes of roads. These classes of roads should permit integrated resource use. For example, a class IV timber road by itself is temporary; however, the planning process may indicate the future need for a recreational road or for development drilling in the area. Then, this road should be developed to accommodate those needs or have an alignment that will satisfy these users.

3. ROUTE SELECTION PROCESS

As land use pressure increases, the involvement of regulatory agencies of disciplines such as fisheries, wildlife, recreation, parks and forestry has increased in the route selection process. The process of selecting a route with due consideration for the constraints of these disciplines can be achieved after carefully assessing several alternatives.

3.1 THE COMPONENTS OF THE ROUTE SELECTION PROCESS

A route selection consists of engineering, socio-economic and biophysical components (Table 2). A road will generate constraints in any or all of these components. In uninhabitated areas, such as the majority of the Green Area, the biophysical and engineering components are the most significant, while in settled areas, the socio-economic component becomes the most significant. A road developer must present the advantages and disadvantages of alternative proposals, the rationale of choosing a particular route and the trade-offs made (unavoidable impacts requiring protection planning). In this manner, a sound proposal can be successfully defended before various interest groups, government review agencies and land owners.

A thorough routing study is a multidisciplinary undertaking. Routing objectives have to be established for each component affected during project conceptualization. Those responsible for the engineering component may establish such objectives as minimizing cost and providing a well-designed facility, while those responsible for the biophysical component would have the objectives of "avoiding" disturbance to sensitive parts of the environment and "minimizing" disturbance to, or interference with, other existing planned land/water resource uses (Table 3). Similar objectives may be established for the socio-economic component, when planning routes in populated areas.

3.2 THE PHASES OF THE ROUTE SELECTION PROCESS

Each route selection is unique. This uniqueness, as it relates to the biophysical component, is based on the environment traversed, type of road to be constructed, nature and type of existing developments and availability of data. The process for route selection consists of two distinct phases, each including six steps (Table 4).

Phase I — Regional Study. Phase I identifies broad, feasible corridors. These corridors are wide, elongated land areas selected on broad resource capabilities, uses and potential impacts. Information collected is compiled and evaluated at a 1:50 000-1:250 000 scale. One or more corridors are selected for a detailed evaluation of their potential routes on the basis of the best balance between the biophysical, socio-economic and engineering components.

Phase II — Detailed Route Selection. Phase II, carried out in greater detail, selects one or more routes within the preferred corridor(s) selected by Phase I.

The components of route selection are analyzed in detail for each selected corridor for the potential impacts that must be avoided and those that can be suitably mitigated. The routes and route alternatives are identified within each corridor followed by further analysis involving detailed air photo interpretation, aerial reconnaissance and ground checks. Data is assessed and compiled at a 1:10 000-1:50 000 scale for further evaluation (Figure 2). The proponent then can define a route within the corridor boundaries that best represents a reasonable and equitable compromise between the biophysical, socio-economic and engineering components.

NOTE: For further information and discussion, see Passey and Wooley 1980.

Table 2

COMPONENTS OF THE ROUTE SELECTION PROCESS

Biophysical	Socio-Economic	Engineering
Biophysical setting Land-use and land capabilities Aquatic systems Atmospheric conditions Environmental hazards	Employment Population Housing requirements Services Community land and infrastructure Regional infrastructure Social adjustment considerations	Design standards Length Safety Reliability Capital investment Maintenance costs Quality of service Terrain Climate Strategic nodes

SOURCE Adapted from Passey and Wooley 1980

Table 3

BIOPHYSICAL COMPONENTS OF THE ROUTE SELECTION PROCESS

1. Biophysical Setting (a) Landforms and surficial materials (b) Soils (c) Existing and climax vegetation (d) Surface and subsurface drainage (e) Climate	4. Atmospheric Conditions (a) Temperatures (b) Inversions (c) Precipitation (d) Potential sources of air pollutants
2. Land-Use and Capabilities (a) Agriculture (b) Forestry (c) Grazing (d) Heritage resources (e) Land status and designation (f) Minerals and petroleum resources (g) Recreation (h) Urban uses (biophysical factors) (i) Wildlife (j) Visual resources	5. Noise Levels, frequency, etc.
3. Aquatic Systems (a) Water quantity (b) Water quality (c) Benthic fauna (d) Fish	6. Environmental Hazards (a) Snow (b) Avalanches (c) Landslides (d) Mudflows (e) Windstorms, earthquakes, floods (f) Fire

Passey and Wooley 1980

Table 4

ROUTE SELECTION PHASES

PHASE 1 REGIONAL STUDY	PHASE 2 DETAILED ROUTE SELECTION
Objective To locate, assess, and compare regional study corridor(s). 1. Identify study area's size and shape. 2. Compile and analyze biophysical data (existing in many cases as published, small-scale maps and records).[a] 3. Identify alternative corridors. 4. Identify impacts along corridors. (Reconnaissance site investigations are required for such things as potential river crossings.) 5. Measure impacts. 6. Rank corridors according to environmental impacts.	Objective To locate, assess, and compare routes within preferred corridor(s). 1. Determine study area by corridor boundaries. 2. Conduct detailed biophysical data inventory and analysis within preferred corridor(s). (Site investigations.) 3. Identify routes and route alternatives within preferred corridor(s). 4. Identify impacts of the chosen route(s). 5. Measure impacts of the chosen route(s). 6. Rank routes by least environmental impact.

SOURCE: Passey and Wooley 1980

NOTE: Successful selection of a route is followed by detailed design and construction.

[a]Engineering and socio-economic data are analyzed concurrently.

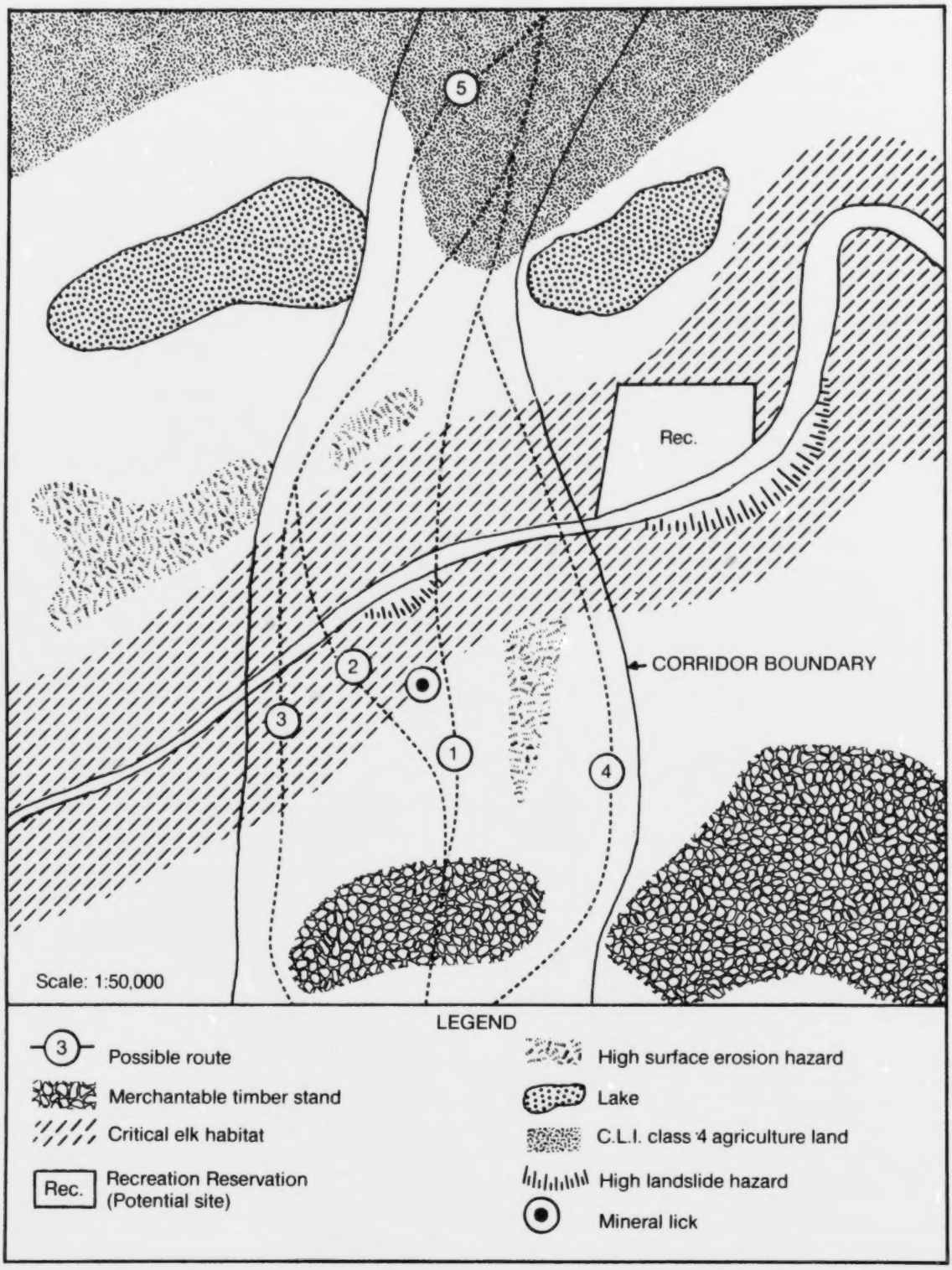

Figure 2. DETAILED ROUTE ALTERNATIVES

SOURCE: Passey and Wooley 1980.

PART II:

The Environmental Protection Guidelines

4. ENVIRONMENTAL PROTECTION GUIDELINES

The environmental protection guidelines are measures and considerations to assist in minimizing the environmental impact of roads during the final plan preparations, design and construction stages of the road. Table 5 presents a summary of the environmental protection guidelines for each road class. Table 5 is designed to be used in conjunction with Table 1, to facilitate in the selection of the appropriate road class.

4.1 DETAILED PLAN PREPARATION

Environmental impacts are identified during the route selection process. Detailed plans show the location of resources affected and quantify potential environmental concerns.

The level of detail required in plan preparation depends on the amount and degree of impact created by the proposed road. In general, the higher the class of road (i.e., class 1) and the greater the engineering that goes into the design of the road, the greater the need for in-depth planning.

Permanent Roads. Detailed plan submissions should show the route alignment on aerial photo stereo pairs, an aerial photo mosaic or an ortho photo mosaic map. Accompanying the photographs should be a forest cover map (1:15 000-1:50 000) showing road alignment and stream crossings; a large scale plan-o-metric map (1:400) showing the route alignment and the survey stations along the route; a center line profile with an exaggerated vertical scale; and a cross sectional profile where the route negotiates steep terrain, side hills, approaches to streams and other critical sites.

Temporary Roads. Detailed plans should show the route alignment and stream crossings on aerial photographs and forest cover maps (1:15 000-1:50 000). Lineal profiles and cross sectional profiles may be required for critical areas. Information on the type and size of stream crossing structures may also be required. The larger the stream, the higher the standard of design information required.

4.2 FIELD LAYOUT

The amount of effort put into field layout depends on the road class and the amount of engineering design in the road proposal.

Permanent Roads. These roads require flagging or blazing of the center line for preliminary inspection and flagging of the right-of-way edges prior to clearing. Permanent roads should be properly surveyed with a base line established and grade staked as required according to the road class. Cuts and fills over 1.5 m should be staked. Any additional requirements to accommodate cuts and fills will be determined during AFS inspection for approval.

Temporary Roads. These roads should be traversed with the center line marked or flagged and flagging of the right-of-way edges prior to clearing. Construction stakes are only required on critical sites.

4.3 DESIGN AND CONSTRUCTION

The design and construction specifications (Table 5) are treated as a single facility right-of-way. A single facility right-of-way for purposes of road construction should be developed with due respect for the level and degree of secondary usage it will receive, by other industrial users as well as the general public. Additional rights-of-way required for other facilities such as powerline and pipelines must be applied for under separate application.

A typical cross section illustrating road design criteria is presented in Figure 3. These design criteria ultimately determine the character of the road.

The importance of topographical location, fragile soils and proximity to streams determines many of the potential environmental impacts of roads which in one case can be minimized by reduced road and clearing widths, while in another case can be minimized by topographic conformity.

4.3.1 Right-of-Way

The right-of-way includes all the cross sectional elements of the road such as clearing widths, cut slopes, fill slopes, road surface widths and drainage ditches.

Clearing widths should be kept to a minimum and tailored to construction and safety requirements. Clearing operations which extend beyond normal earthwork procedures for grade and ditching should be limited to brushing and stumping. The limits for clearing widths in Table 5 are preferred, however justifications may be required if these limits are exceeded. This may include requirements for increase in sight distance, topographical constraints or increased exposure of road surface for drying. Tree height should be considered in evaluating right-of-way requirements. Excessive clearing should be avoided to reduce the total amount of land base taken out of production.

Traditionally, rights-of-way were cleared with linear edges according to the right-of-way edge survey lines. To be environmentally acceptable, however, this should be modified to provide a curvilinear edge on either side of the right-of-way (Figure 4).

Variable width clearing of the right-of-way can appear as natural features. This can be accomplished through proper reclamation on borrow pits located on the right-of-way, by selective cutting of trees susceptible to blowdown, by selective cutting to enhance scenic view, through additional land requirements for slopes and timber decking or as part of the road design. Variable width may be appropriate in some areas but not in others.

The angle of cut and fill slopes is dependent on soil type, soil stability and water bearing capacity. The majority of erosion on roads is attributed to these slopes. Locating roads on ridges, moderate slopes, fitting the alignment to topography (Figure 5) providing adequate drainage and stabilizing slopes decreases surface disturbance and reduces erosion. The amount of soil erosion expected increases as slope increases. Some land

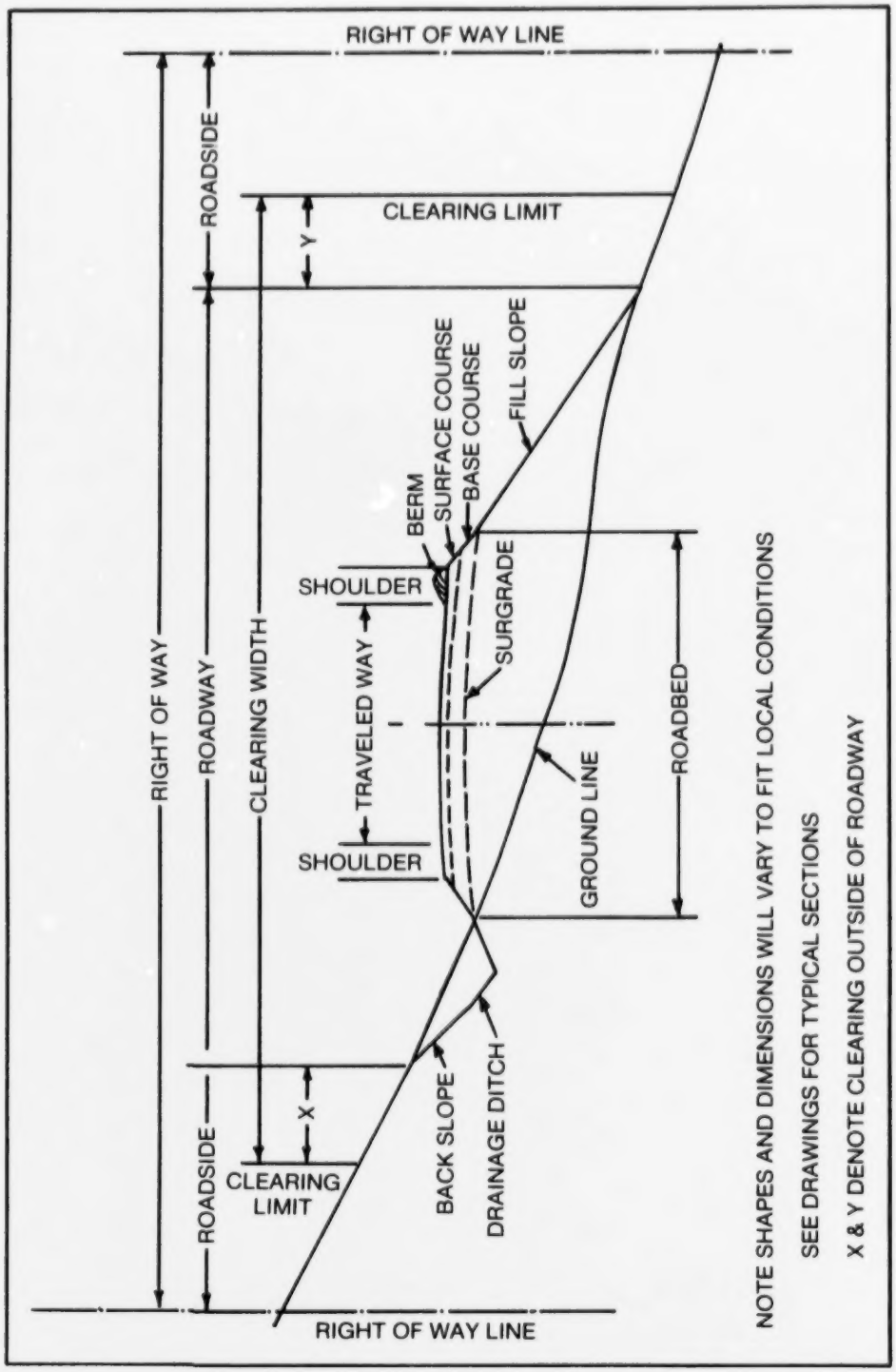

Figure 3. TYPICAL CROSS SECTION OF ROAD DESIGN CRITERIA
SOURCE: USDA 1977b.

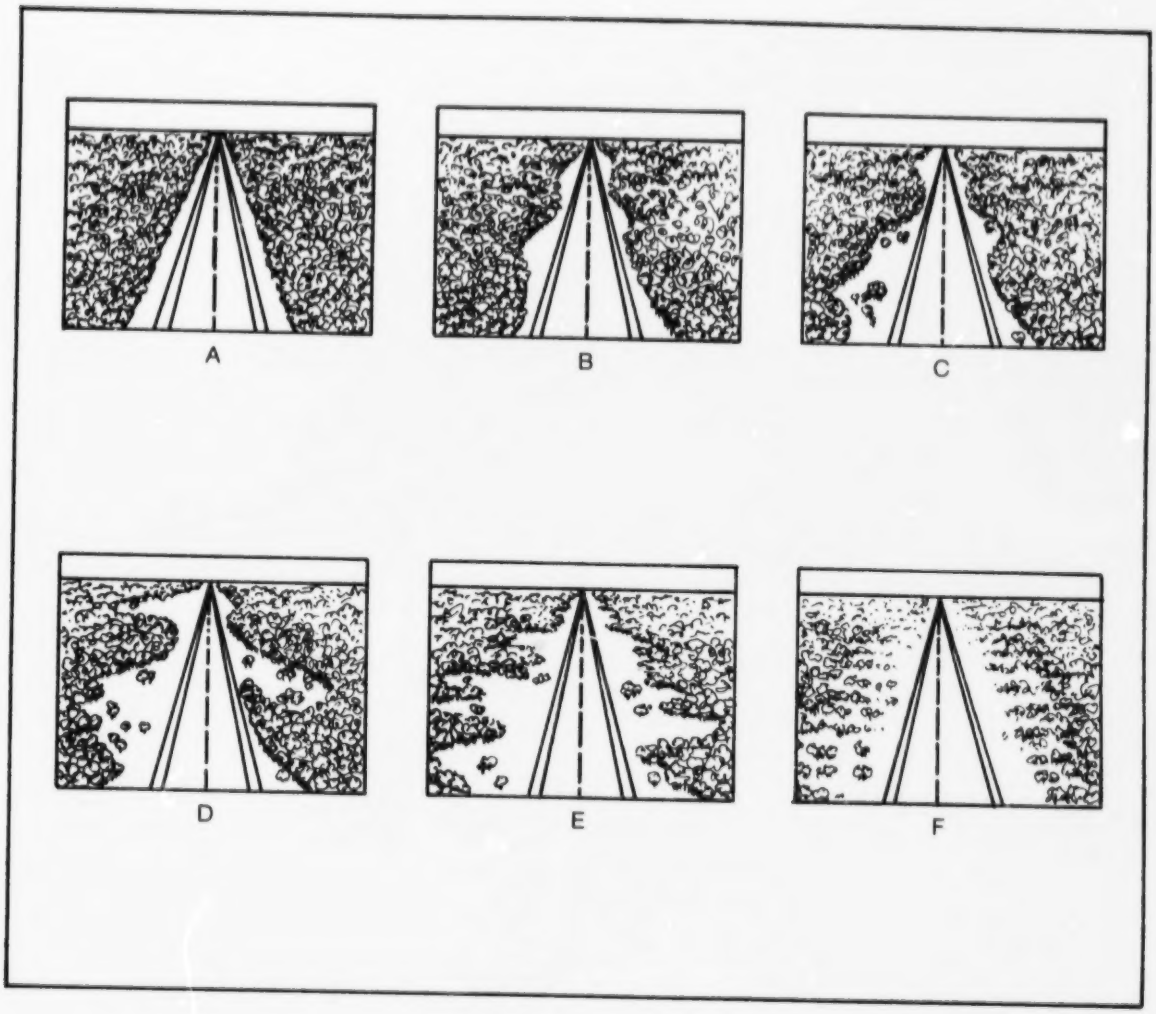

Figure 4. DEGREES OF VARIABLE WIDTH RIGHT-OF-WAY. The continuous use of either one of these features (i.e., A) can approach a level of monotony and become inappropriate from foreground to horizon. A combination of several of these features (i.e., D and F) would reduce the monotony and be more in proportion to the landscape over straight tangents. On rolling /rugged terrain, these microsite clearings are sequenced with cuts where cut slopes are extended. The vegetation projections are synonomous with fill slope locations, coming within the minimum allowable distance from the toe of the fill slope.

SOURCE: Adapted from USDA 1973, p. 15.

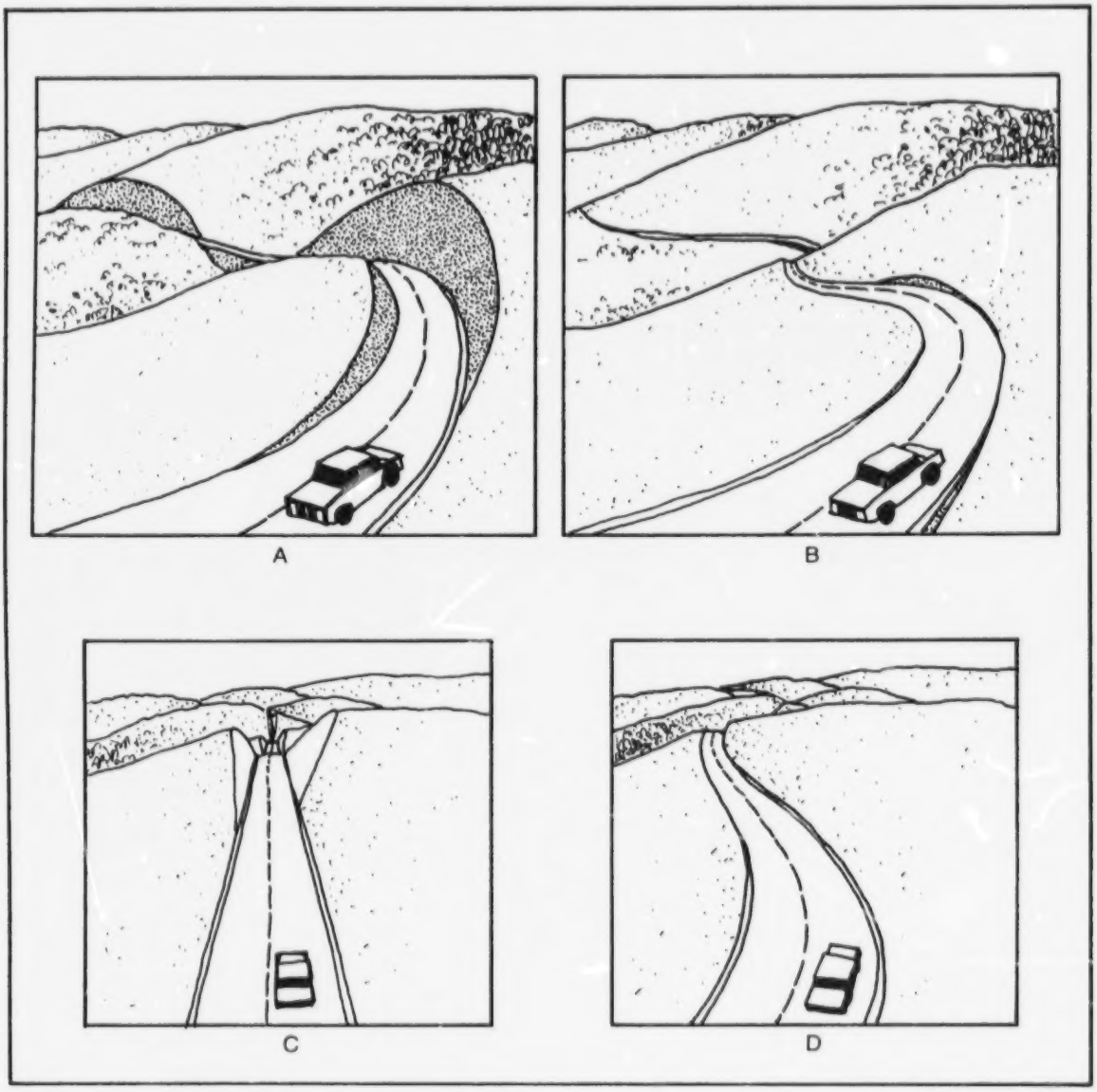

Figure 5. TOPOGRAPHIC CONFORMITY OF ROAD ALIGNMENT.
An obvious landform modification in A could have, by grade and alignment revisions looked like B. The visual impact of alignment C might have been minimized by alignment in D.

SOURCE: Adapted from USDA 1977a, p. 11 and 21.

Table 5. ENVIRONMENTAL PROTECTION GUIDELINES

ROAD DESCRIPTION		ROUTE SELECTION PROCESS		ENVIRONMENTAL PROTECTION GUIDELINES																											
ROAD CLASS	TERM OF LIFE	PHASE I	PHASE II	DETAILED PLAN PREPARATION	FIELD LAYOUT	DESIGN AND CONSTRUCTION																									GUI
						RIGHT OF WAY							ALIGNMENT									BORROW PITS	TIMBER SALVAGE	DEBRIS DISPOSAL	STREAM CROSSINGS						
						Clearing Width	Back Slopes b.		Fill Slopes b.		Road Surface	Drainage Ditch	Gradients c.				Sight Distance	Minimum Radius of Curve	Design Speed						BRIDGES		CULVERTS				
							N	E	N	E			F		A															
													S	P	S	P														
I	Permanent	Phase I	Phase II	Detailed design plan on air photos or photo mosaics. Cross sectional profiles for stream crossings and cuts and fills over 1.5m. Types of structures for stream crossings, erosion control measures, hydrological information, revegetation and reclamation plans required. Right-of-way requirements specified and where any additional requirements may be necessary.	Centerline and stations marked before A.F.S. field inspection. Both sides of right-of-way to be marked before construction commences. Cuts and fills over 1.5m must be staked. Any additional right-of-way requirements to accomodate cuts and fills will be determined during A.F.S. inspection for approval.	40m	2:1	3:1	2·5:1	3:1	10m	Rounded or Scraper	5	7	4	5	180m	300m	90 km/h	Locations identified before construction commences and site tested for materials and ground water levels before clearing of borrow area. Dog-legged access or access constructed at an angle with buffer to off right-of-way borrow pits. Borrow pits located on the right-of-way should be incorporated by variable width and recontouring.	Timber salvage will be done as per timber management regulations.	Total disposal except strippings and fine debris (10cm or less) to be retained for erosion control by spreading on cuts and fills and any other critical areas and walked in by a crawler.	Bridges are the preferred crossing structure and may be required where biological, hydraulic and/or terrain characteristics are significant. Should be designed to facilitate other resource users	Culverts 1.8m diameter or over to have installation supervised by an engr. Culverts with diameter less than 1.8m to be supervised by qualified project manager. All culverts designed for 1.5 flood level. All culverts to be rip-rap and aproned. Culverts placed in fish bearing streams must facilitate fish passage
II	Permanent	Phase I	Phase II	See class I	See class I	30m	2:1	3:1	2·5:1	3:1	10m	Rounded or Scraper	6	8	5	6	150m	230m	80 km/h	See class I	See class I	See class I	See class I	See class I
III	Permanent	Phase I	Phase II	See class I	See class I	20m	2:1	3:1	2·5:1	3:1	8m	Rounded or Scraper	8	10	6	8	90m	120m	60 km/h	See class I	See class I	See class I	See class I	See class I
IV	Permanent	–	Phase II	See class I	See class I	10-20m d.	2:1	3:1	2·5:1	3:1	6m	See class IV temporary	10	12	8	10	45m	50m	40 km/h	See class I	See class I	See class I	See class I	See class I
IV	Temporary	–	Phase II	Road alignment plan on aerial photographs and forest cover maps. Profiles of critical areas (cuts, fills, and stream crossings). Types of structures for stream crossings.	Centerline marked for A.F.S. field inspection. Both sides of right-of-way marked before construction commences.	10-20m d.	2:1	3:1	2·5:1	3:1	6m	"V" ditches where required. Ditches should be rock lined where site specifics (grade and slope) may dictate their use.	10	12	8	10	45m	50m	40 km/h	Use of small borrow pits incorporated into right-of-way where possible.	See class I	Partial disposal -mechanical or manual cutting of accumulated slash and debris to reduce fire hazard to acceptable levels. Must be spread on right-of-way and walked in by a crawler	Portable bridges and/or native timber bridges are preferred (See class I) Properly constructed logfills or ice bridges on intermittent streams. Temporary crossings must be removed before spring breakup.	See class I Designed for a 1 year flood level.
V	Temporary	–	Phase II	See class IV temporary	See class IV temporary	8-20m d.	2:1	3:1	2·5:1	3:1	5m	See class IV temporary	12	14	12	14	—	—	—	See class IV temporary	See class I	See class IV temporary	See class IV temporary	See class IV temporary

a. Refer to text for further discussion.
b. N-normal soils, E-erosive soils.
c. F-favorable, A-adverse, S-sustained, P-pitch
d. Class IV and V roads have a maximum clearing width of 20m. Terrain and/or additional facilities on right-of-way may dictate a 20m right-of-way from the desired 10m and 8m for class IV and V respectively.

ES

ENVIRONMENTAL PROTECTION GUIDELINES

ED PLAN ARATION	FIELD LAYOUT	DESIGN AND CONSTRUCTION GUIDELINES [a]																		ROAD ABANDONMENT	
		RIGHT-OF-WAY						ALIGNMENT							BORROW PITS	TIMBER SALVAGE	DEBRIS DISPOSAL	STREAM CROSSINGS		EROSION CONTROL AND REVEGETATION	MAINTENANCE	TEMPORARY	PERMANENT
		Clearing Width	Back Slopes [b] N	Back Slopes [b] E	[b] es	Road Surface	Drainage Ditch	Gradients [c] F S	Gradients [c] F P	Gradients [c] A S	Gradients [c] A P	Sight Distance	Minimum Radius of Curve	Design Speed				BRIDGES	CULVERTS				
d design plan photos hosaics Cross profiles for ssings and fills over 1.5m. structures for rossings, erosion asures, hydrolo- rmation, revegeta- reclamation quired. Right-of- irements speci- where any ad- requirements ecessary.	Centerline and stations marked before A.F.S. field inspection. Both sides of right-of-way to be marked before construction commences. Cuts and fills over 1.5m must be staked. Any additional right-of-way requirements to accomodate cuts and fills will be determined during A.F.S. inspection for approval.	40m	2:1	3:1	3:1	10m	Rounded or Scraper	5	7	4	5	180m	300m	90 km/h	Locations identified before construction commences and site tested for materials and ground water levels before clearing of borrow area. Dog-legged access or access constructed at an angle with buffer to off right-of-way borrow pits. Borrow pits located on the right-of-way should be incorporated by variable width and recontouring.	Timber salvage will be done as per timber management regulations.	Total disposal except strippings and fine debris (10cm. or less) to be retained for erosion control by spreading on cuts and fills and any other critical areas and walked in by a crawler.	Bridges are the preferred crossing structure and may be required where biological, hydraulic and/or terrain characteristics are significant. Should be designed to facilitate other resource users	Culverts 1.8m in diameter or over to have installation supervised by an engineer. Culverts with diameter less than 1.8m to be supervised by a qualified project manager. All culverts designed for 1:50 yr. flood level. All culverts to be rip-rapped and aproned. Culverts placed in fish bearing streams must facilitate fish passage.	Progressive reclamation (recontouring cuts and fills and revegetation) concurrent with construction. Recommended seed mixture as per the resource handbook to be applied by hydroseeding, mulching, or other approved means. Cross drains and ditch blocks dictated by slope and soil conditions. Drainage water to be diverted off the right-of-way in as short a distance as possible.	Annual maintenance required. Maintenance plan may also be required.	Removal of all crossing structures, additional erosion control measures implemented and active maintenance required.	Complete removal of all crossing structures and engineering aspects of the road. Recontouring of road to original state and fertilizing and seeding of right-of-way
lass I	See class I	30m	2:1	3:1	2.5:1	3:1	10m	Rounded or Scraper	6	8	5	6	150m	230m	80 km/h	See class I	See class I	See class I	See class I	See class I	See class I	See class I	See class I	See class I
ass I	See class I	20m	2:1	3:1	2.5:1	3:1	8m	Rounded or Scraper	8	10	6	8	90m	120m	60 km/h	See class I	See class I	See class I	See class I	See class I	See class I	See class I	See class I	See class I
ass I	See class I	10-20m [d]	2:1	3:1	2.5:1	3:1	6m	See class IV temporary	10	12	8	10	45m	50m	40 km/h	See class I	See class I	See class I	See class I	See class I	See class I	See class I	See class I	See class I
gnment plan on otographs and r maps. Profiles reas (cuts, fills, crossings). Types s for stream	Centerline marked for A.F.S. field inspection. Both sides of right-of-way marked before construction commences.	10-20m [d]	2:1			3:1	6m	"V" ditches where required. Ditches should be rock lined where site specifics (grade and slope) may dictate their use.	10	12	8	10	45m	50m	40 km/h	Use of small borrow pits incarporated into right-of-way where possible.	See class I	Partial disposal -mechanical or manual cutting of accumulated slash and debris to reduce fire hazard to acceptable levels. Must be spread on right-of-way and walked in by a crawler.	Portable bridges and/or native timber bridges are preferred (See class I) Properly constructed logfills or ice bridges on intermittent streams. Temporary crossings must be removed before spring breakup.	See class I Designed for a 1:25 year flood level.	See class I Portable seed broadcasters or manual casting may be used.	See class I	See class I	See class I
IV temporary	See class IV temporary	8-20m [d]	2:1			3:1	5m	See class IV temporary	12	14	12	14	—	—	—	See class IV temporary	See class I	See class IV temporary	See class IV temporary	See class IV temporary	See class IV temporary	See class IV temporary	See class I	See class I

surfaces are subject to slumping (Photo 3). Aerial photo interpretation, field inspections and lab analysis of soil samples can be used to assess soil erosion hazard and slope stability. Figure 6 illustrates the structural features of a slump and how cuts and fills affect slump stability. Steep roadcuts may be used if the total area of soil to be exposed to erosion can be reduced (Table 6), provided that the shear strength of the soil is not exceeded. Exposed slopes greater than 2:1 are more likely to have erosion problems (Figure 7).

Slash and debris should be spread over the cut slope and fill slope areas as it can be used to control soil erosion and facilitate revegetation (Photo 4). The degree to which this is used is dependent upon other considerations such as fire hazards, type of road and time since it was developed.

The road surface width should be adequate to allow safe passage of vehicles. The class of road dictates these requirements with more emphasis on higher class roads which will have more vehicle traffic than lower class roads. The crown of the road should outslope to ditches to allow for drying and drainage of the road surface. Site specific situations may require berms on the road surface edge to transport water to prepared ditches. Permanent roads will require a gravel surface. Temporary roads for winter use only generally do not require a road base; however, site specific situations may require fill in soft spots. Roads located on the south aspect of slopes will dry sooner than roads located on a north aspect.

Photo 3. Unstable soil conditions have resulted in slumping on this cut slope. Note the leaners, fallen trees and overhanging vegetation mats.

Photo 4. Debris spreading on disturbed portions of the right-of-way is used to control erosion and to facilitate revegetation by providing sites for re-establishment.

During grade preparation, top soil, strippings, slash and debris may be salvaged and stored at approved sites (Photo 5). When grade is complete, the topsoil can then be respread on exposed cuts and fills and other exposed areas to facilitate a quick return of vegetation after revegetation procedures are complete.

Grade preparation in muskeg areas is critical for road stability and drainage. Extreme care must be taken to prevent crust breakage of the muskeg surface. Breakage of the crust often results in road failure, erosion and severe drainage problems. Geotextile felt products and porous polypropylene materials offer a wide variety of solutions in muskeg areas and other poor soil and drainage areas (Photo 6). The basic function of these materials is to act as a reinforcing and separation membrane between the subgrade and aggregate fill. It increases the load bearing capacity, prevents mixing of subgrade and fill and allows for passage of water.

A drainage system is a system to intercept, collect and remove surface and subsurface runoff from roads. If a drainage system is inadequately blocked or underdesigned, excess water can erode surfaces, weaken grades, cause slumping and washouts and result in higher maintenance costs.

Control measures for erosion are numerous and often are site-specific; however, with any type of drainage system used, rip-rap, ditch blocks, gabions, and revegetation of exposed areas should always be employed initially as a preventative measure rather than a solution to a recurring problem. Spreading debris on exposed surfaces also reduces erosion and encourages vegetation.

At all times, proper drainage must be incorporated into road construction to minimize erosion on the road surface, the cut and fill slopes or the ditches. In order to achieve this, the following may be required in many instances:

1. Roads should be well ditched and provided with adequate culverts, of proper size and alignment to handle peak runoffs, to minimize water movement along ditches and the road surface (Photo 7).
2. No ditch should drain directly into a watercourse unless limited by topography and approved in writing by a Forest Officer in consultation with the Fish and Wildlife Habitat Biologist. Ditch blocks are to be installed where required (Photo 8 and Photo 9).
3. All drainage water should be diverted, if possible, so that it does not pass over fills or collect in cuts, borrow areas, or waste dumps.
4. Adequate spillways should be provided if culverts outfall on unstable areas or road fill materials.

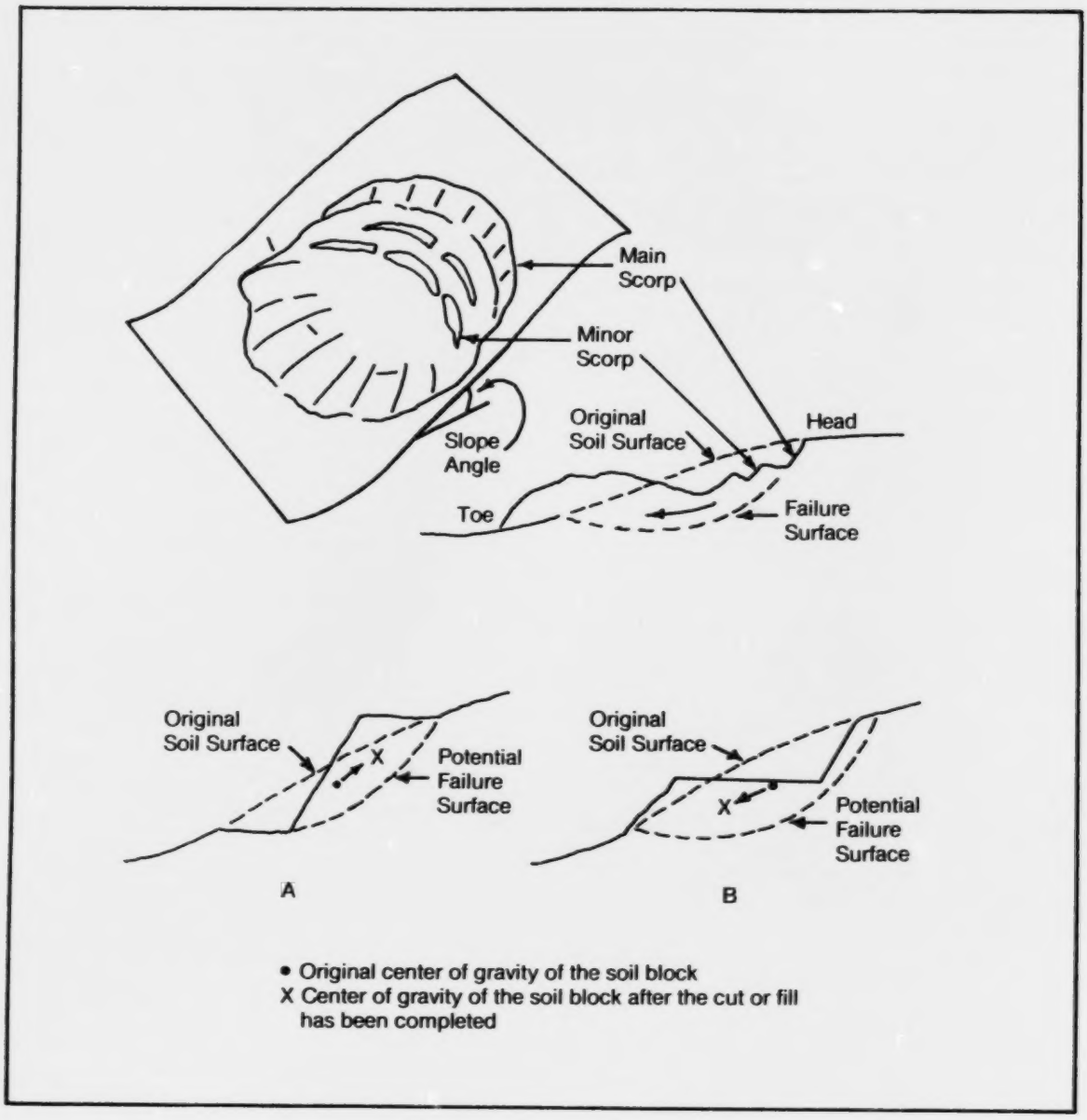

Figure 6. STRUCTURAL FEATURES OF SLUMPS. Loading the head and/or unloading the toe in A shifts the center of gravity upwards and ***increases*** *the potential for slumping. Loading the toe and/or unloading the head in B shifts the center of gravity downwards and* ***decreases*** *the potential for slumping.*

Adapted from Pedology consultants 1979, p. 8.

Table 6

CUT SLOPE AND FILL SLOPE ANGLES FOR DIFFERENT SOIL MATERIALS

Cut Slopes		Fill slopes	
Flat ground cuts under 0.9 m	2:1	Common for most soil	1:1
Most soil types with ground slopes under 55%	1:1	Alluvial soils	2:1
Most soil types with ground slopes over 55%	3/4:1	Ballast	1:1
Hardpan or soft rock	1/2:1	Clay	4-1:1
Solid rock	1/4:1	Rock, crushed	1-1/4:1
		Gravel	1:1
		Sand, moist	1 1/2-1:1
		Sand, saturated	2:1
		Shale	1 1/2:1

SOURCE: USDA 1960.

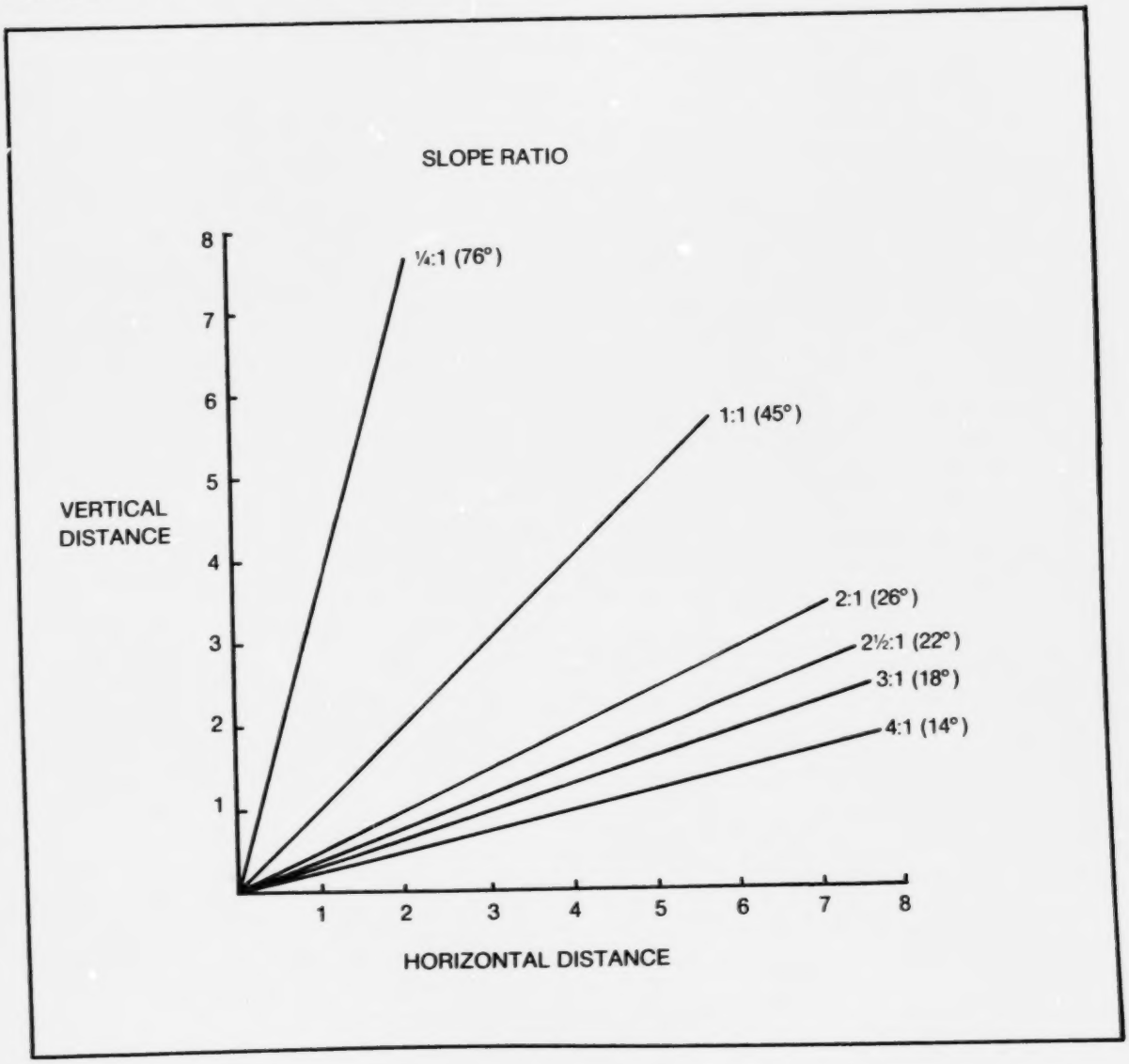

Figure 7. SLOPE RATIO AND CORRESPONDING ANGLES FOR CUT SLOPES AND FILL SLOPES.

5. Sediment catch basins should be provided at the entrance to major culverts if deemed necessary by the Forest Officer.
6. Special erosion control measures may be required on cuts or fills greater than 6 m (20 feet) to reduce bank erosion, including measures such as contour trenches or terracing.
7. Culverts should be rip-rapped, as necessary, to prevent erosion at both inflow and outflow ends.
8. Culverts or other drainage devices should be placed at an angle to the road so as to attain maximum drainage efficiency.
9. Buffer strips should be left where roads on steep slopes are close to important streams. Where vegetation strips are employed for water filtration and do not effectively retard sediment movement, a system of obstruction (i.e., logs, rocks, mounds) shall be placed between the drainage outlet and watercourse.
10. "V" ditches should be rock-lined where site-specific situations such as grades and slopes dictate this requirement to minimize erosion and gullying. On scraper or rounded ditches, rock lining may also be required in site-specific situations to minimize erosion and gullying.
11. Cross drains may be required where grades and soil conditions permit. Cross drains should be placed to divert water off the right-of-way into surrounding vegetation in as short a distance as possible (Photo 10). Where conditions do not permit cross drains, other measures such as ditch blocks should be used.
12. Where the outflow ends of culverts are located near the top of fill slopes, down spouts should be installed to transport water down the slope into prepared ditches. Temporary measures such as the use of plastic can be employed during construction stages.

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Photo 5. Topsoil stored on the right-of-way. Most salvage operations are stored at approved sites off the right-of-way.

Photo 6. Rolls of geotextile fabric are examined before placement on the road subgrade. The fabric increases the load-bearing capacity and prevents mixing of subgrade and aggregate fill in muskeg areas and in other poor soil and drainage areas.

Photo 7. An underdesigned culvert unable to handle runoff has resulted in ponding on the roadside. The potential for washout is high and the occurrence is common.

Photo 8. Rock ditch blocks placed at frequent intervals on a slope to minimize erosion. Although effective, they must be placed properly and aggregate size should be larger than depicted.

Photo 9. Gully erosion on a steep grade resulting from improperly placed straw bales used as ditch blocks. To be more effective, straw bales should be dug in and staked.

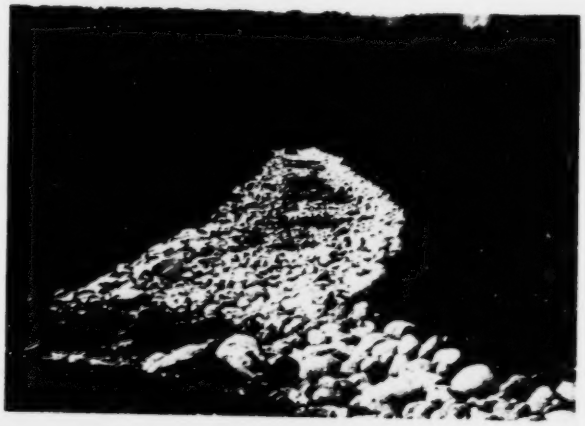

Photo 10. A rock-lined cross drain with a downspout on the fill side has been placed to divert water into the surrounding vegetation and to prevent erosion of the exposed surface.

4.3.2 Alignment

Horizontal and vertical alignments control the movement and speed of vehicular traffic on tangents, curves and grades. Alignment should conform to topography. Conforming the road to topography minimizes alterations in natural conditions, minimizes potential erosion problems and reduces visual impact (Figure 4).

Performance of vehicles on grades depends on grade length, gradient, approach speed, vehicle weight and power. A significant drop in speed on steep grades can be hazardous to following vehicles and can result in higher maintenance costs on vehicles which consistently use these types of roads. The economics of hauling times can also be affected by steep grades. Low grades are desirable as vehicle speed can be maintained without a significant loss in speed.

Sight distance is directly related to the design speed of each class of road. Passing distances may be provided on higher class roads. On lower class roads, passing of vehicles is not common enough to design in detail for; however, passing distances should be taken into consideration.

Sight distance and design speed are the controlling factors for vertical and horizontal curves. Many curves exist as blind corners and are usually the result of poor road placement. If vehicle speed is higher than the road is designed for, or if the driver is unfamiliar with the road, these corners become a danger to the driver and any oncoming vehicles. Right-of-way widening on some corners or shifting the road within the right-of-way increases the safety factor in terms of sight distance.

4.3.3 Borrow Pits

Borrow pits are used to obtain materials to construct the road base. Wherever possible, existing borrow sites should be used. Development of new borrow pits should be planned and located before construction and should be tested for materials and ground water levels before clearing commences. Off right-of-way borrow pits must be approved by the regulatory authority (i.e. AFS).

Borrow pits located off the right-of-way should retain a buffer strip of a minimum of 90 m from the roadway. The access road to the borrow pit should be dog-legged or constructed at an angle to reduce sight distance and to screen the pit from the roadway. Wind-firm timbered areas are preferred for off right-of-way locations.

Wherever possible, borrow pits should be located on the right-of-way. These sites can be suitably incorporated into the right-of-way with proper reclamation procedures for variable width.

Borrow pits located near lakes and watercourses should be adequately buffered and measures should be provided to ensure no sedimentation from the borrow pit to the lake or watercourse occurs.

Upon termination of use of a borrow pit, the borrow pit should be stabilized and recontoured for proper sloping and revegetation. Some borrow pits can be suitably altered to provide habitat for waterfowl and aquatic mammals of the area if conditions permit or reforested.

4.3.4 Timber Salvage

Timber is an important renewable resource. It is

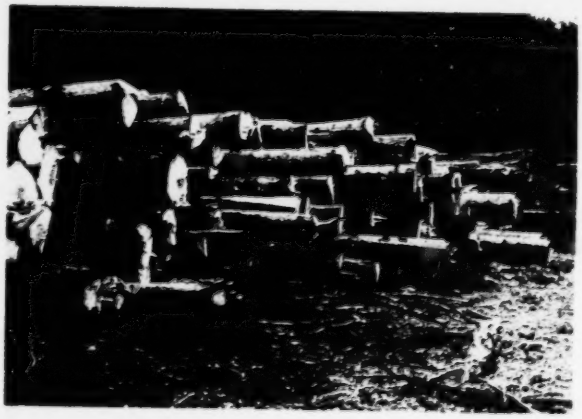

Photo 11. Merchantable timber salvaged from the right-of-way clearing operations has been placed in a manner to facilitate pick up and removal.

imperative that precautions be taken to minimize timber loss through right-of-way clearing.

Timber salvage is required pursuant to The Timber Management Regulations of The Forests Act. Specific sections pertaining to industrial use include sections 146 to 153.

Timber salvage utilization standards are generally based on the local economy such as saw log, pulp, and post operations. Salvageable timber must be lopped and decked in a manner facilitating pick up and removal (Photo 11).

4.3.5 Debris Disposal

Debris disposal refers to the total or partial disposal of unsalvageable timber, brush, roots and other debris on the right-of-way. The Forest and Prairie Protection Regulations Part II of The Forest and Prairie Protection Act provide legislation pertaining to debris disposal. Specific sections include sections 3, 4, 5, 17 and 18.

Permanent Roads. Total disposal refers to the complete removal and disposal of trees and brush by burning and/or limited burying (of materials which cannot be burned) to reduce fire hazard and improve aesthetics.

All permanent roads require total disposal of debris. This is most often done by burning; however, location and time of year may dictate other disposal methods which can be specified by the Forest Superintendent. These disposal methods may include slash reducing implements such as a land breaker, hydro-axe or mechanical chipper, provided all merchantable coniferous timber has been salvaged on the right-of-way. Any burning must be done at a safe time of year to minimize the spread of fire and requires the issuance of a provincial burning permit during the fire season.

Temporary Roads. Partial disposal refers to the mechanical or manual cutting of accumulated slash and debris to reduce the fire hazard to acceptable levels and to improve aesthetics.

Partial disposal is generally required for all temporary roads. Partial disposal requires the spreading of all debris on exposed surfaces and crushing by heavy machinery. Another method includes windrowing of debris but debris must not be piled against standing timber. These methods may differ with the use and class of the temporary road.

4.3.6 Stream Crossings

The placement of a stream crossing structure in or across a stream is required to allow safe vehicle passage across the stream. The type of stream crossing to be used depends on a visual inspection of the proposed crossing point and a study of hydrological data. The class of road to be built and the present and future use of the road also influence the choice of a stream crossing structure.

Stream crossings are termed as either temporary (less than 2 years) or permanent (2 years or greater).

Temporary stream crossings include:

1. Fords
2. Snow and ice bridges
3. Log, pipe and snow fills
4. Culverts
5. Spanning or native timber bridges, and portable bridges

Fords are used as a temporary crossing when vehicle loads are greater than the load bearing capacity of the existing structure, during the repair, maintenance and construction of a crossing, or as a naturally occurring crossing vantage. The condition of the stream bed is the most important factor for determining crossing points for fords. The crossing must occur only where conditions permit.

Snow and ice bridges require many man hours of preparation before the load bearing capacity is reached. Continual maintenance is also required and have limitations in terms of time and economics (man hours).

NOTE: Stream Crossing Guidelines are being developed by ENR.

Log, pipe and snow fills are often placed into a watercourse to serve as a crossing point. Log and pipe fills are sometimes bundled together for easy placement and removal at the crossing. Snow fills are used in winter operations on ephemeral draws and small permanent non-fish-bearing steams.

Culvert use is extensive as a temporary crossing on ephemeral streams, non-fish-bearing streams and on fish-bearing streams (Photo 12). Bridges are preferred structures for stream crossings; however, economics are often the deciding factor for alternatives. The native timber bridge (Photo 13), is the most common temporary and permanent bridge used by industry. Portable bridges have been receiving more use by industry recently due to ease of placement, removal and cost.

Permanent crossings are basically restricted to the use of culverts and bridges (Photo 14) with higher engineering design standards.

To design for a culvert or bridge crossing and to

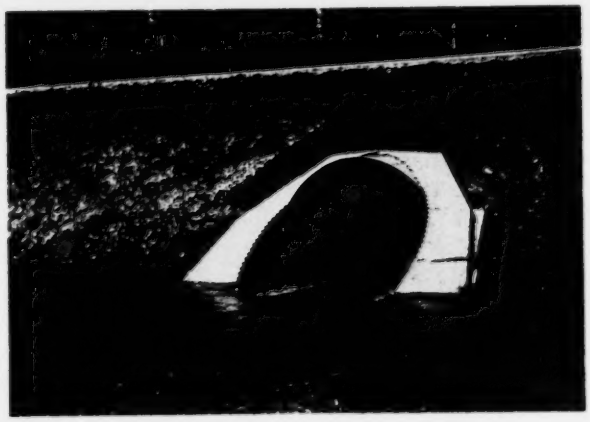

Photo 12. A well designed, placed and protected culvert.

properly locate the crossing site, precipitation characteristics, peak water flows, drainage basin, profiles, stream hydraulics, vegetation, soils, fish capability and road gradient must be evaluated. A water resources permit from the Water Rights Branch of Alberta Environment may have to be obtained prior to commencement of construction.

On all fish-bearing streams, bridges are the preferred crossing structures; however, culverts are used more frequently. Culverts located in fish-bearing streams must be designed to facilitate fish passage. The Alberta Fish and Wildlife Division may assist in the design of a culvert for fish passage.

Other considerations that apply to stream crossings are:

1. All locations and designs of proposed crossings of permanent and intermittent streams should be shown in Phase II of the route selection process.
2. All stream crossings and bridges should be located and constructed so as to result in minimum erosion damage and sediment deposition in stream channels (Photo 15). Preventive measures shall be implemented at the time of construction.
3. On permanent roads (watercourse crossing infrastructures with a desired life of 10 years or more), the crossing design should accommodate a 10-year return period or more, based on a 50-year peak flow event. The examination of records of water flow prepared by the federal and/or provincial government departments concerned may provide storm event information. Should such records not be available, estimates of maximum flow rates may be made based on the area of the drainage basin or other appropriate data.
4. When culverts are installed on large permanent, small permanent and intermittent watercourses identified as fish-bearing, they should not restrict fish passage. Installation of the culverts should be timed so as not to interfere with fish spawning movement. The Regional Habitat Biologist of the Fish and Wildlife Division must be contacted on timing constraints for construction in and around watercourses.
5. Where stream alteration or diversion work or alternatives to No. 4, above, are required, the company should first consult with the Forest Superintendent regarding the requirement for alternative work. A detailed plan and description shall be required and submitted with the understanding that ample lead time is needed for a detailed study by government agencies.
6. Where hanging culverts are permitted on non-fish-bearing streams, the flow ends of the culverts should be provided with downspouts or other suitable drains, where necessary. Rock or concrete aprons

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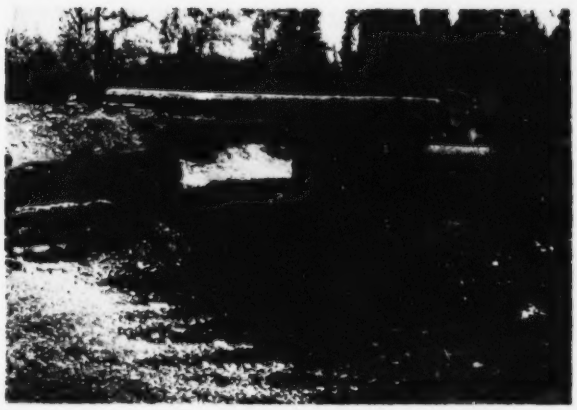

Photo 13. A native timber bridge which has been treated and well placed and constructed on this stream.

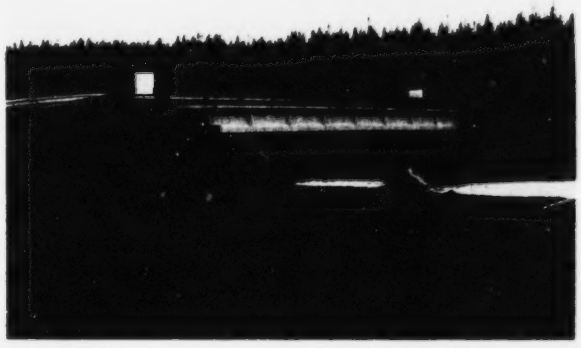

Photo 14. A concrete spanning bridge on a petroleum access road.

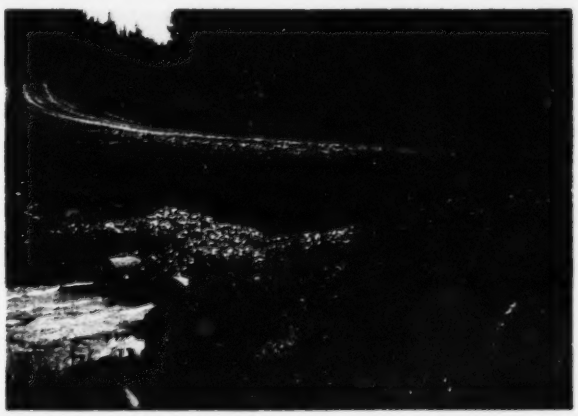

Photo 15. Undermining of road and partial washout has resulted from inadequately placed and designed culverts.

should be provided to decrease water velocity and prevent stream channel gouging.

7. When temporary crossings have been constructed during the winter season across any watercourse, such crossings shall be completely removed before spring breakup unless otherwise approved by a Forest Officer.

4.3.7 Erosion Control and Revegetation

Two types of erosion generally occur: geological erosion (which occurs under natural conditions) and accelerated erosion (which is man-induced through surface disturbance). Factors which affect the severity of erosion are climate, soil characteristics, degree and length of slope, vegetation and industrial practices. Once the vegetative cover is removed, the land surface becomes highly susceptible to erosion, especially by water.

When a right-of-way is being prepared, it is extremely important that precautions and safeguards are exercised to avoid soil inception into a watercourse and to avoid deterioration of the road and the consequent costly maintenance repairs.

While construction of the road proceeds, erosion control measures, reseeding and fertilizing of bared surfaces (Photo 16) should follow behind construction. The recommended maximum distance is 2 km. This should be completed within one growing season of completion of construction to ensure soil stability. Fertilizer and seed mixture should be used as recommended in **The Resource Handbook** (Alberta Forest Service 1979).

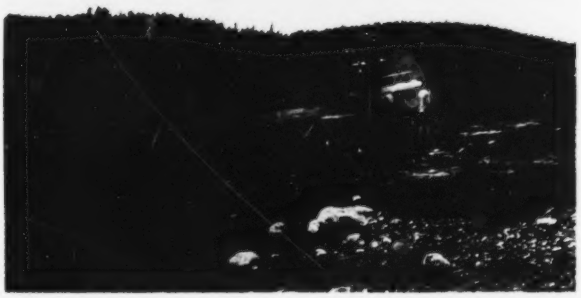

Photo 16. A hydro-seeder being used to ensure adequate coverage for vegetation re-establishment on this fill.

The Public Lands Act provides legislation for the control of erosion as does section 21 of the Forest and Prairie Protection Regulations Part II.

4.3.8 Maintenance

All roads, stream crossings and drainage structures shall be maintained in such a manner as to allow proper drainage and to prevent erosion. This may include annual clean-out of culverts, ditches, erosion control structures, and any additional seeding and fertilizing. Proper grading of road surfaces should ensure no spreading of gravel onto shoulders and no ridges left on roadway edges.

In areas where potential and/or existing problems occur, maintenance plans may be required. These plans should contain details of work required on a site specific basis and be reviewed between the operator and forest officer. In regions that are particularly sensitive to erosion, maintenance plans on all roads may be required.

During the road design and construction phase, consideration should be given to the establishment of a long-term plan for the management of right-of-way vegetation. The vegetation management plan would be part of the maintenance plan and take into consideration such aspects as aesthetics, road safety, noxious weed control, wildlife habitat, erosion control, right-of-way width control, and stream crossings. The plan would set out what operations and frequency of operations are required on various sections of the right-of-way. Maps of appropriate scale would be very useful in delineating the various sections of the right-of-way requiring different treatments. For example, it may be appropriate to spray aspen regrowth on one section of the right-of-way but other areas such as stream crossings or recreation areas may require brush mowing.

4.3.9 Aesthetics

Aesthetics includes the scenic quality, appearance and attractiveness of the roadway and surrounding landscape. Depending on the use each road is to receive, higher constraints may be placed for visual resources on some roads than on others (i.e., there is a continuum of use from recreation in one case to industrial in the other). Aesthetics should be evaluated in the preliminary stages of alignment location and roadway design. Roads that may principally be for recreational use may have a significant industrial component or vice versa.

Four basic steps may be followed in planning and managing the visual resource:

1. Assess the natural landscape for visual elements to establish a base condition prior to any development.
2. Design various alternatives and assess the view.
3. Choose the best alternative and improve or modify as necessary to maximize this visual quality.
4. Document the visual resource management plan to ensure maximum adherence through all stages of road development.

These four basic steps are preliminary to any road construction and include the involvement of government agencies through the planning process. Depending on the scope and type of road, the public affected by the development may also be involved.

Many of the items relating to aesthetics, environmental protection and construction are complementary. To separate criteria into those that are desirable for each is not feasible. Conforming the road to topography, for

example, is preferred from a construction and environmental point of view as the numbers of cuts and fills are reduced. It also enhances the visual aspect of the road as well as reduces the potential amount of erosion and sedimentation into a watercourse. The road with topographic conformity may be longer in total length, but that does not mean it will be more costly in the long term.

Many positive features of construction, when properly performed and applied, can benefit the overall road appearance and satisfy the envrionmental concerns. Site-specific situations always arise on any road and usually require consultation between the road designer and a Forest Officer.

During or after construction, enhancement of the visual resource to increase the aesthetic value varies with the type of road.

Enhancement may include such basic practices as back slope rounding (Photo 17), supplemental planting of shrubs and trees (Photo 18), or selective thinning to open views. More consideration and effort would be applied to a road for recreational use than one for a timber or petroleum industry use. Specifics for visual enhancement occur as a natural feature of the road due to topography or as a concerted effort in the design planning stages.

To recognize aesthetic values and to maintain high environmental standards, the following integral features should be considered:

1. The road should be located to take advantage of scenic quality.
2. The road should fit the topography rather than slash through it.
3. The road should avoid combinations of horizontal curves.
4. The length of road visible at any one time should be limited, but appear continuous without breaks.
5. The road should direct attention to positive visual features. Curvature allows the road to fit and blend into topography as well as provide optimal viewing of desired features.
6. Undersirable features should be concealed or attention directed away from them if the road location cannot avoid them. Undesirable views are easier to conceal on short tangents between two curves. When this is not possible, berms or plantings are alternatives.
7. The use of minimum cuts and fills enhances natural roadside values and reduces erosion and siltation potential.
8. Slopes should be rounded as a positive means of blending landform modifications (Figure 8).
9. The clearing line should be set initially from 3-5 m outside the edge of rounding on cuts and from 1-3 m outside this point on fills (Figure 9).
10. Right-of-way clearing should undulate by variable width cutting (Figure 4). Continued straight edge clearing provides monotony.
11. Vegetative clearing should be compatible with the surrounding landscape.
12. Top soil should be stripped and stock-piled and respread on cuts and fills and other disturbed areas to assist in a good return of vegetation after seeding and fertilizing.
13. Borrow pits should include buffer strips to avoid viewing from the road and/or incorporated into the right-of-way and landscaped and revegetated to have the appearance of a natural meadow or of variable width.
14. Specific views should be enhanced through selective clearing or partial removal of roadside vegetation.
15. Erosion and construction disturbance should be kept to a minimum.
16. Revegetation should occur as soon as possible after top soiling is complete. Progressive reclamation is desirable.
17. Where sight distance is not sufficient, the road should be shifted from the centreline rather than widening the right-of-way.
18. The choice of rip-rap at bridges and culverts should

Photo 17. Slope rounding on these cut slopes enhances the roadside value and avoids overhanging mats of vegetation.

Photo 18. Tree plantings on this cut slope will enhance the roadway and assist in stabilization.

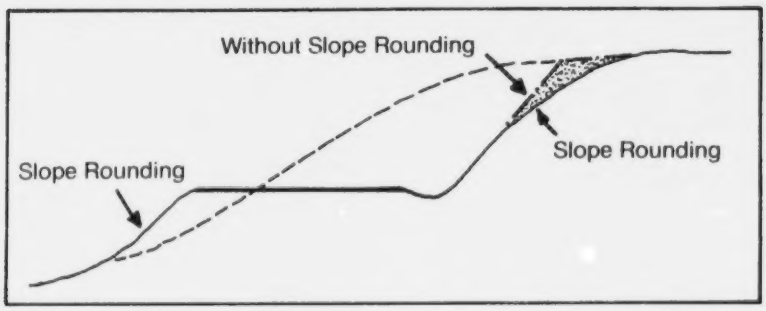

Figure 8. SLOPE ROUNDING.
This is a positive means of blending landform modifications with existing landforms. It breaks the sharp, unnatural edges formed by the junction of a constant-pitch cut slope with the naturally-rounded landform. Slope rounding is also beneficial for revegetation.

SOURCE: USDA 1977a, p. 12

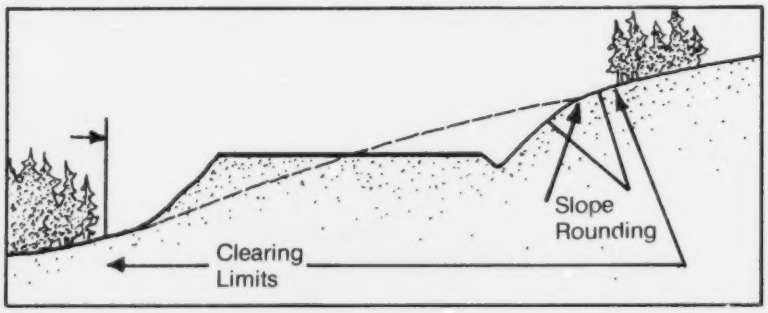

Figure 9. RIGHT-OF-WAY CLEARING LIMITS.
Clearing limit requirements may be excessive in some cases to allow sufficient manoeuvring room for construction equipment. In most cases, clearing just to the edge of designed grading may suffice. The clearing line should be set initially from 3-5 m outside the edge of rounding on cuts and from 1-3 m outside this point on fills.

SOURCE: USDA 1977a, p. 22

be made visually compatible with surrounding terrain.

19. Rock cuts should be designed to resemble the appearance of natural rock.
20. Culvert ends should be cut to conform with the slope and the cut edges painted with a rust preventative paint.
21. The design and colour of structures (i.e., bridges) and appurtenances (i.e., guardrails) should be compatible with both the function of the road and the surrounding landscape.

All of these features have, in part or in whole, been incorporated into many roads to ensure, maintain and manage aesthetics and environmental resources. The visual resources in particular, in locations such as the Eastern Slopes, certainly require more attention towards protection and enhancement due to the ever-increasing demands being made upon present and future resource development and ultimate recreational end use.

4.3.10 Other Resource Considerations

The Alberta Fish and Wildlife Division has the mandate to manage, develop and improve fish and wildlife populations and their habitats within the province. With road development, there is loss of wildlife habitat, loss of streamside habitat, soil erosion into streams, increased

public access, and in some cases (depending on the intensity of industrial activity) the removal of wildlife populations and loss of a fishery resource.

Many of the items discussed in the previous sections relate to these concerns. Variable width right-of-way and curvilinear design increases the "edge effect" and reduce the line of sight for wildlife. Streamside protection, erosion control measures and reclamation of disturbed surfaces will reduce the inception of soil into watercourses and ensure a rapid growth of vegetation and cover species for fish and wildlife populations. These measures are related to the construction and design of the road; however, the aspect of road location in Phase I and Phase II of the route selection process is the most important in avoiding important fish and wildlife areas.

In 1977, **A Policy for Resource Management of the Eastern Slopes** outlined wildlife zones and, in particular, critical wildlife zones. Critical wildlife zones consist of ranges or habitats such as key winter ranges, migration routes and calving areas that are essential to the survival of specific wildlife populations. Since this report, the Fish and Wildlife Division has produced wildlife capability maps outlining in more detail the different wildlife zones for the province. The study of these maps by the planner can ensure that critical areas and other important areas are avoided at early stages.

Each species of fish has a spawning time and some have migration times. To ensure the preservation of spawning grounds and minimal disturbance or obstruction of migrations, timing constraints have been placed on any industrial activity in or around streams by the Alberta Fish and Wildlife Division. The Regional Habitat Biologist should be contacted on the site specifics for timing constraints.

Some wildlife zones also have timing constraints. These can be for summer construction or winter construction depending on the wildlife species or the importance of the area to wildlife. Some wildlife zones are very restrictive in the type of development that may be proposed.

Increased public access through exploration and development roads often increases legal and illegal hunting practices and recreational use. The result is often a quick and noticeable decline in ungulate populations and a slower decline in other wildlife populations. Some access roads, especially initial exploration roads, may have to be controlled with gates and/or manned gates. Industrial users should use existing roads or develop them among themselves to reduce the amount of access.

Archaeological resources include historic sites and archaeological surveys to preserve and record historic sites and artifacts. As a guide, the archaeological resource sensitivity zones map may be referred to, to determine the probability that significant archaeological resources will be encountered. Regardless of the sensitivity zone rating, it does not preclude that a site will or will not be encountered. Many of the major waterway systems have a high sensitivity rating for archaeological resources. The Historical Resources Division of Alberta Culture may be consulted to determine the value and probability of encountering any archaeological resources. An archaeological survey may be required to determine the resource value or importance of artifacts or importance as an historic site.

4.4 ROAD ABANDONMENT

Road abandonment is directly related to the purpose of the road and the type of use the road will receive. During the planning stages, the possibility of abandonment should be considered.

4.4.1 Temporary Abandonment

Temporary abandonment of a road requires complete removal of all drainage and crossing structures. Cross drains, diversion ditches and other erosion control measures must be installed as necessary. Although the grade remains, all exposed surfaces should be revegetated. Entry onto the road should be blocked and an active maintenance program implemented.

4.4.2 Permanent Abandonment

Permanent abandonment of a road requires the complete removal of all drainage and crossing structures on the road right-of-way. The right-of-way must be reclaimed in such a manner that vegetative cover is established to stabilize soil, the environment is consistent with the landforms and productivity is comparable to the undisturbed condition. Varying degrees of reclamation may be required in high value or sensitive areas.

Scarification of road surface, recontouring of the right-of-way (Photo 19), replacement of soil material and surface strippings and seeding of an acceptable plant species are requirements of permanent abandonment. Debris may be scattered on the right-of-way (Photo 20), and compacted for erosion control and revegetation purposes. Road blocks may have to be incorporated on all access points to the right-of-way to discourage vehicle traffic and to allow stabilization and regrowth of the abandoned right-of-way.

Photo 19. This abandoned access road has been properly recontoured to a form similar to that prior to construction of the road.

Photo 20. Debris and logs on this temporary exploration road have been pulled back and scattered on the right-of-way for erosion control and for blocking access in critical wildlife zones.

Glossary

GLOSSARY

Aesthetic Value — the characteristic(s) of an area which is pleasing to the human eye, particularly when the area is in its natural state.

Berm — a man-made embankment of soil used to divert water resulting from rainfall.

Buffer Strip — a strip of undisturbed land adjacent to a disturbed area that retards the flow of runoff water, causing deposition of transported material thereby reducing sedimentation of receiving streams.

Corridor — wide, elongated land areas for linear developments that are selected based on broad resource capabilities, uses, and potential impacts. Corridor width may vary from 1.5-16 km depending on types and sizes of linear developments.

Cross Drain — a ditch constructed horizontal to the disturbed slope for the purpose of retarding the flow, thereby reducing the sediment load.

Debris — surface stripping, slash, stumps, unmerchantable timber and brush.

Ditch Blocks — a barrier constructed across a drainageway to retard water flow and to form a small, sediment catch basin. Ditch blocks are usually constructed from timbers or piled-up rocks, or gabions.

Diversion Ditch — a channel constructed across a slope to intercept surface runoff, changing the course of all or part of a stream or runoff, thereby reducing sediment problems.

Erosive Soils — soils which are highly susceptible to erosion, once the vegetative cover has been removed, as a result of factors such as texture, structure and water holding capacity.

Gabions — compartmented rectangular containers made of thickly galvanized steel wire mesh, of various sizes. The baskets are filled on site with stones. When installed, the gabion becomes a large, flexible and permeable building block used to control erosion and stabilize slopes.

Hydro Seeding — a hydraulic method used to seed an area. Mulch and fertilizer are also commonly incorporated into the spraying mixture.

Merchantable Timber — forests which have 25 or more green coniferous trees, exceeding 15 m in height, on any hectare of land to be cleared.

Mulching — the addition of material (usually organic) to disturbed land surfaces to combat erosion and retain soil moisture.

Partial Disposal — mechanical or manual cutting of accumulated slash and debris done to reduce the fire hazard to acceptable levels and to improve aesthetics.

Reclamation — returning the land to a condition and productivity in comformity with the prior land use objective of maintaining a balanced ecological state that does not contribute substantially to environmental deterioration and is consistent with aesthetic values.

Recontouring — grading disturbed land to an acceptable landform.

Recreation Area — potential and designated land areas which have been reserved or are used for recreational purposes.

Revegetation — the process of seeding, tree planting, fertilization, etc. to establish vegetation in an area where the vegetation was previously removed.

Rip-Rap — stones and rock which are used to prevent erosion from occurring in a given area.

Routes — elongated land areas with a width of 0.5-1.0 km defined within a corridor. The alignment for a linear development is located within a selected route based on detailed resource capabilities, uses and potential impacts.

Sediment — solid material, both mineral and organic, that is in suspension, being transported, or has been moved from the site or origin, by air, water, gravity or ice.

Sedimentation — the deposition of sediment.

Slash — the branches, bark, tops, cull logs, and broken or uprooted trees on the ground after logging.

Steep Slope — slope in excess of 27 degrees from the horizontal.

Total Disposal — complete removal and disposal of trees and brush by burning and/or limited burying to reduce fire hazard and improve aesthetics.

Topsoil — surface soil, includes the organic layer in which plants have most of their root system.

Vegetation Management — the establishment and fostering of desirable vegetation and the control of unwanted vegetation.

Watercourse

- — bed and shore of a river, stream, lake, creek, or other natural body of water.
- — canal, ditch, reservoir or other man-made surface structure to contain or convey water, whether it does so continuously or intermittently.

References

REFERENCES

Adam, K. M. 1978. Building and Operating Winter Roads in Canada and Alaska. Environmental Studies No. 4. Northern Environmental Protection and Renewable Resources Branch. Department of Indian and Northern Affairs.

Adamovich, L. 1971. Geometric Design Standards of Forest Roads: An Aesthetic View: **In**: The Effects of Roads on our Forest Environment. 8th Canadian Roadside Development Conference. U.B.C. Vancouver.

Alberta Fish and Wildlife Division, 1980. Fisheries Habitat Guidelines No. 4 and No. 6 Alberta Energy and Natural Resources.

Alberta Forest Service, 1979. The Resource Handbook. Alberta Energy and Natural Resources, Edmonton, ENR Report No. 75.

Bourgeois, W. W. 1979. The Impact of Inadequate Drainage Structures on Soils and Forest Resource. **In**: Drainage Structures for Logging Roads. Sponsored by the Association of B.C. Professional Foresters and the Centre for Continuing Education, the University of B.C.

Case, A. B. and D. A. Rowe, 1978. Environmental Guidelines for Resource Road Construction. Forestry Service. Fisheries and Environment Canada. NFLD For. Res. Cent. Info. Rep. N-X-162.

Chamberlin, T. W. 1979. Environmental Implications of Inadequate Drainage Structures. **In**: Drainage Structures for Logging Roads. Sponsored by the Association of B.C. Professional Foresters and the Centre for Continuing Education, the University of B.C.

Colorado Department of Highways, 1978. I-70 In a Mountain Environment. Vail Pass, Colorado. FHWA-TS-78-208.

Curran, H. J. B. and H. M. Etter, 1976. Environmental Design for Northern Road Developments. Environmental Protection Service. Northwest Region. Environment Canada. Report EPS-8-EC-76-3.

Environment Council of Alberta, 1979. The Environmental Effects of Forestry Operations in Alberta. Report and Recommendations. Environment Council of Alberta, Edmonton.

Gardner, R. B., 1967. Major Environmental Factors that Affect the Location, Design, and Construction of Stabilized Forest Roads. Vol. XXVII "Loggers Handbook". Pacific Logging Congress, Portland, Oregon.

Gardner, R. B., W. S. Hartsog and K. B. Dye, 1978. Road Design Guidelines for the Idaho Batholith Based on the China Glenn Road Study. USDA For. Ser. Res. Pap. INT-204. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Gardner, R. B., 1979. Some Environmental and Economic Effects of Alternative Forest Road Designs. Transactions of the American Society of Agricultural Engineers (ASAE) 22 (1): 63-68.

Gator, A. and M. Seaby, 1978. Parks Canada Road Classification System and Geometric Design Standards. DRAFT. Dept. of Indian and Northern Affairs Engineering and Architecture, Transportation Division.

Groves, F. D., R. K. Baughman, M. E. Hundley, and R. L. Sherman, 1979. Timber Haul Road Construction in Southern Mountains. Southern Journal of Applied Forestry 3(3): 68-76.

Haupt, H. F., 1959. A Method for Controlling Sediment from Logging Roads. Intermountain Forest and Range Experiment Station. USDA For. Serv. Ogden. Utah. Misc. pub. No. 22.

Henderson, C., 1977. Timber Harvest Cut Block Design. Timber Management Branch. A.F.S. Alberta Energy and Natural Resources, Report No. 43.

Holmes, D. C., 1978. Manual for Roads and Transportation. Volume 1. Forest Resource Technology. B.C. Institute of Technology.

Holmes, D. C., 1978. Manual for Roads and Transportation. Volume 2. Forest Resource Technology. B.C. Institute of Technology.

Kosick, R., 1979. The Cost of Inadequate Drainage Structures. **In**: Drainage Structures for Logging Roads. Sponsored by the Assoc. of B.C. Professional Foresters and the Centre of Continuing Education, the University of B.C.

Larse, R. W., 1971. Prevention and Control of Erosion and Stream Sedimentation from Forest roads. **In**: Proceedings of a Symposium, Forest Land Uses and Stream Environment. P 76-83. Oregon State University.

Leary, C. W., n.d. Erosion Control and Reclamation During Road Installation. Unpublished report. Alberta Forest Service, Alberta Energy and Natural Resources.

Leary, C. W., n.d. Erosion Control and Reclamation of Disturbed areas. Unpublished report. Alberta Forest Service, Alberta Energy and Natural Resources.

Litton, R. B. Jr., 1968. Forest Landscape Description and Inventories — A Basis for Land Planning and Design. Berkely, Calif., Pacific SW Forest and Range Exp. Sta. USDA For. Serv. Res. Pap. PSW-49.

Lotspeich, F. B., 1971. Environmental Guidelines for Road Construction in Alaska. Environmental Protection Agency, Alaska Water Laboratory, College, Alaska. Report No. 1610-G01-08/71.

McLoughlin, K. T., 1979. Access Road and Stream Crossing Considerations. J. of Arboriculture 5(9):201-205.

McNamara, J., A. Moore and J. Baerwald, 1975. Design Guidelines for Recreational Roads. Army Construction Engineering Research Laboratory. Champaign, IL. Report no. CERL-TR-D-63.

Megahan, W. F. and W. J. Kidd, 1972. Effects of Logging and Logging Roads on Erosion and Sediment Disposition From Steep Terrain. J. of For. 70(3):136-144.

Ministry of Mines and Petroleum Resources, 1978. Handbook of Environmental Protection and Reclamation in Coal Exploration. DRAFT. Province of British Columbia.

Mumford, G. T. and S. Talbot, 1976. Forest Access Roads. Construction Guidelines. Nova Scotia Department of Lands and Forests. Truro. N.S. CAT/76/12/12.

Ontario Ministry of Natural Resources, 1973. Design Guidelines for Forest Management. Prepared by Hough, Stansbury and Associates Ltd. Toronto, Ontario.

Ontario Ministry of Natural Resources, 1979. Class Environmental Assessment for Access Roads to Ministry of Natural Resources Facilities. OMNR Toronto, Ont.

Ontario Ministry of Transportation and Communications, 1978. Highway Vertical Alignment. (S1 Metric). Vertical Curve Considerations. Design and Construction Branch.

Packer, P. E., 1967. Criteria for Designing and Locating Logging Roads to Control Sediment. Forest Science 13(1):2-18.

Passey, G. H., and D. R. Wooley, 1980. The Route Selection Process. A Biophysical Perspective. Alberta Energy and Natural Resources. Edmonton.

Paterson, W. G., H. W. McFarlane and W. J. Dohaney, 1976. Standard Classification for Forest Roads. FERIC Tech. Rep. No. 9.

Pedology Consultants, 1979. Terrain Evaluation of the Goose Tower Haul Road Corridor. Phase II. Prepared for Imperial Lumber Ltd.

Pragnell, R. C., 1970 Scenic Road. A Basis for its Planning, Design and Management. USDA For. Serv. Engineering Tech. Rep. ETR-7700-2.

Roads and Transportation Assoc. of Canada, 1976. Geometric Design Standards for Canadian Roads and Streets. Metric ed. Roads and Transportation Association of Canada, Ottawa.

Rothwell, R. L., 1978. Watershed Management Guidelines for Logging and Road Construction in Alberta. Fisheries and Environment Canada. Can. For. Serv. Nor. For. Res. Cent. Edmonton, Alberta. Info. Rep. NOR-X-208.

Rothwell, R. L., 1978. Erosion Control on Forest Roads. Agriculture and Forestry Bulletin 1(4):29-32.

Rowe, L. W., 1974. Habitat Protection; Recommended Guidelines for Construction and Forestry. Environment Canada. Fisheries and Marine Service. Resource Development Branch. Newfoundland Region. Info. Rep. Ser. No. NEW/N-74-1.

Stewart, J. W., 1979. National Park Roads in the U.S.A.: Purposes and Design Standards. Parks 3(4):15-18.

Stubbs, C. W. B. and B. J. Markham, 1979. Wildlife Mitigative Measures for Oil and Gas Activity in Alberta. **In**: The Mitigation Symposium: A National Workshop on Mitigating Losses of Fish and Wildlife Habitats. USDA For. Serv. Gen. Tech. Rep. RM-65. Colorado State University, Fort Collins, Colorado.

Swanston, D. N., 1971. Principal Mass Movement Processes Influenced by Logging, Road Building and Fire. **In**: Proceedings of a Symposium, Forest Land Use and Stream Environment. p 29-39. Oregon State University.

University of British Columbia, 1971. The Effects of Roads on Our Forest Environment. 8th Canadian Roadside Development Conference. U.B.C., Vancouver.

U.S. Department of Agriculture, 1960. Preconstruction Guide. USDA For. Serv. Reg. Six. Portland, Oregon.

U.S. Department of Agriculture, 1973. National Forest Landscape Management. Volume 1. USDA For. Serv. Agricul. Handbook No. 434.

U.S. Department of Agriculture, 1977a. National Forest Landscape Management. Volume 2. Chapter 4. Roads. USDA For. Serv. Agricul. Handbook No. 483.

U.S. Department of Agriculture, 1977b. General Provisions and Standard Specifications for Construction of Roads and Bridges. EM-7720-100, USDA For. Serv. Wash. D.C.

Ward, A. L., J. J. Cupal, G. A. Goodwin and H. D. Morris, 1976. Effects of Highway Construction and Use on Big Game Populations. USDA For. Serv. Rocky Mountain For. and Range Experiment Station. Fort Collins, Colorado. 80521.

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